

Claims

1. Method for pre-emphasis of an optical wavelength division multiplex signal, of which the signals with different wavelengths assembled in groups (B1, B2, B3, B4) are

5 transmitted over express channels as well as over drop channels, add channels or add-drop channels of a transmission link (LWL) with a number of sections, characterized in that,

a number of sub-pre-emphasis settings of the groups (B1, B2,

10 B3, B4) of signals are made at injection points (NE, OADM) of the sections of the transmission link (LWL) such that to achieve predetermined average optical signal-to-noise ratios(OSNR1, OSNR2, OSNR3, OSNR4) of the different groups (B1, B2, B3, B4) of signals at their termination points, the average 15 power of at least one group (B1, B2, B3, B4) of signals is reset at least one injection point of a section shared with the group (B1) of the express channels.

2. Method in accordance with claim 1,

characterized in that

20 at the injection point the average signal power of a group with drop channels or add-drop channels dropped or terminated at a subsequent drop point is reduced in favor of the average signal power of an onwards-routed group of express channels.

3. Method in accordance with claim 1 or 2,

25 characterized in that

the redistribution of the average signal powers between the groups (B1, B2, B3, B4) in injecting or switching network elements (NE) is undertaken with a signal power regulation.

4. Method in accordance with one of the previous claims.

30 characterized in that

to equalize the signal-to-noise ratios at a termination point of a group (B1, B2, B3, B4) of channels, an additional individual-channel pre-emphasis is performed at its injection point.

5 5. Method in accordance with one of the previous claims.  
characterized in that  
the average signal-to-noise ratios (OSNR1, OSNR2, OSNR3, OSNR4)  
or differences between the signal-to-noise ratios of the  
different groups (B1, B2, B3, B4) of signals at their  
10 termination points are predetermined by a network management  
system.

6. Method in accordance with one of the previous claims 1 to 4,  
characterized in that  
to determine the power modifications to be made, the initial  
15 hypothesis is that all channels at the corresponding point can  
be changed individually and the average power modification of  
the channel group is then calculated from this specification.

7. Method in accordance with one of the previous claims.  
characterized in that  
20 for control of one of the sub-pre-emphasis settings a network  
element (NEi, OADMj) is activated with the aid of a data packet  
which is transmitted outwards and backwards from the first  
injection point (NE0) to the other network element (NEi, OADMi)  
section-by-section and which contains a marking (X) of the  
25 injection and termination points of each of the groups (B1, B2,  
B3, B4) of signals.

8. Method in accordance with claim 7,  
characterized in that  
at a network element (NEi, OADMj) the data packet is used for  
30 control of one of the additional individual-channel pre-

emphases of one of the groups (B1, B2, B3, B4) of signals.

9. Method in accordance with claim 7 or 8,  
characterized in that  
for control of the direction of transmission and the range of  
5 the data packet between the network elements (NEi, OADMj) a  
counter (COUNT) is initialized, incremented or decremented in  
the data packet.

10. Method in accordance with one of the previous claims.

characterized in that  
10 depending on the type of encoding of the counter (COUNT) and  
the marking (X), a regulation protocol provided at a selected  
controlling network element for control of pre-emphasis steps  
with sub-pre-emphasis settings and/or of the additional  
individual-channel pre-emphasis of the groups (31, B2, B3, B4)  
15 along the transmission link (LWL) is selected.

11. Method in accordance with claim 10,

characterized in that  
on receipt of a data packet for which the counter (COUNT) has  
the value "0", a network element (NE1, OADM1, OADM2...) assumes  
20 control of the pre-emphasis steps for its subsequent network  
sections and  
in this case the counter (COUNT) is incremented to the value 1.

12. Method in accordance with claim 10 or 11,

characterized in that  
25 on receipt of a data packet for which the counter (COUNT) has  
the value "1" at a network element (NE1, OADM1, OADM2...), a  
spectrum of the signals as well as the data packet from the  
next network element (OADM1, OADM2, NE2) are sent back along  
the transmission link (LWL) and that for the return journey of  
30 the data packet through each network element (NE2, OADM2,

OADM1) without termination point, the counter (COUNT) is incremented by 1 for all the groups of channels there, otherwise remaining unchanged.

13. Method in accordance with claim 12,

5 characterized in that

for an unchanged counter (COUNT) the data packet is transmitted in an opposite direction.

14. Method in accordance with one of the claims 11 to 13,

characterized in that

10 at one of the network elements (OADM1, OADM2, NE2) with a termination of at least one of the groups of channels a marking (X) is activated in the transmitted data packet for this group and

15 the marking (X) for a group is deleted at the injection point of the same group on return of the data packet.

16. Method in accordance with one of the claims 11 to 14,

characterized in that

on receipt of a data packet of which the counter (COUNT) has a higher value than 1 at a network element (NE1, OADM1, OADM2...)

20 the counter (COUNT) of the data packet transmitted forwards - i.e. in the direction from the first network element (NE1) to the second network element (NE2) - is reduced by 1 if in this case at least one group of channels is not terminated, i.e. is let through or is injected.

25 16. Method in accordance with one of the claims 11 to 15,

characterized in that

on receipt of a data packet of which the counter (COUNT) has a higher value than 1 at a network element (NE1, OADM1, OADM2...)

30 the counter (COUNT) of the data packet transmitted backwards - i.e. in the direction from the second network element (NE2) to

the

first network element (NE1) - is increased by 1 and  
on arrival of the data packet transmitted in the backwards  
direction the counter (COUNT) remains unchanged at the first  
5 controlling network element (NE1).

17. Method in accordance with one of the claims 11 to 16,  
characterized in that  
on arrival of the data packet transmitted backwards at the  
first controlling network element (NE1) with a counter (COUNT),  
10 for which the value is equal to the value at the same network  
element (NE1) with the previous forwards transmission of the  
data packet, the counter is set to the value 0, that the data  
packet is transmitted forwards to the next network element  
(OADM2),  
15 the counter (COUNT) is incremented by the value 1 and thus the  
next network element (NE2) is defined as the new controlling  
network element for control of further pre-emphasis steps.

18. Method in accordance with one of the claims 11 to 17,  
characterized in that  
20 pre-emphasis steps are undertaken at the controlling network  
element at a group of channels for which a marking (X) is  
activated there.

19. Method in accordance with claim 10,  
characterized in that  
25 the pre-emphasis steps are controlled at different selected  
controlling network elements during the transmission of the  
data packet within the transmission link (LWL).

20. Method in accordance with claim 19,  
characterized in that  
30 a network element which receives a data packet with a counter

(COUNT) with the value "1" in an uplink direction UL, returns values of the power spectrum for an unchanged counter to the beginning of the transmission link (LWL) and marks groups of channels which are terminated at this network element.

- 5    21. Method in accordance with claim 19 or 20,  
characterized in that  
a network element which receives a data packet with a value of  
the counter (COUNT) greater than "1" in the uplink direction  
UL, decreases the counter (COUNT) by the value "1" and passes  
10    on the data packet to the next network element.
22. Method in accordance with one of the claims 19 to 21,  
characterized in that  
a network element which receives a data packet in the backwards  
direction, increases the counter (COUNT) by the value "1" and  
15    passes the data packet on to the preceding network element.
23. Method in accordance with claim 22,  
characterized in that  
for all marked groups of channels which are inserted at the  
network element, an individual-channel pre-emphasis is executed  
20    and their corresponding markings are deleted.
24. Method in accordance with one of the claims 19 to 23,  
characterized in that  
for all non-marked groups of channels or groups of channels not  
inserted at the network element an equalization of the average  
25    power is undertaken if the counter (COUNT) has the value 1.
24. Method in accordance with one of the claims 19 to 23,  
characterized in that  
if the value of the counter (COUNT) is not "1", an individual-  
channel pre-emphasis for groups of channels marked and inserted  
30    at the network is performed.

25. Method in accordance with claim 24,  
characterized in that  
the average power per group remains constant.

26. Method in accordance with one of the claims 19 to 25,  
5 characterized in that  
a network element, at which all groups of channels are  
terminated and which receives a data packet in the uplink  
direction UL with a counter (COUNT) with a value "2", transmits  
a data packet with a counter (COUNT) with a value of "0" and  
10 deactivates markings at the preceding network element.

27. Method in accordance with one of the claims 19 to 26,  
characterized in that  
a network element which is not the first element of a network  
section - at which no group of channels will be looped through  
15 - and which receives a data packet with a counter (COUNT) with  
the value "0" in a forwards or backwards direction, passes the  
packet on without change to the preceding network element.

28. Method in accordance with one of the claims 19 to 27,  
characterized in that  
20 the value of the counter (COUNT) increases by "1" step-by-step  
from one pre-emphasis-step to another pre-emphasis-step at the  
network element at the start of the network section until the  
receipt of a data packet with a value "0" of the counter  
(COUNT) signals the completion of the pre-emphasis for this  
25 network section.

29. Method in accordance with one of the claims 19 to 28,  
characterized in that  
a network element, at which all groups of channels are  
terminated preferably at the end of the network section LWL  
30 concerned and which receives a data packet with a counter

(COUNT) with the value "0" in the uplink direction UL,  
initiates one or more pre-emphasis-steps for the subsequent  
network section (LWL') .